# Keene State College: Wintertime Community Air-Sensor Monitoring

**Description:** This project employs a citizen-science network to measure wintertime woodsmoke levels across the city of Keene. Citizens use low-cost Purple Air sensors to measure $PM_{2.5}$, the main indicator pollutant of wood smoke. Sensor data is validated by co-locating the sensors with a federal air-quality monitoring station in Keene. Concentrations are mapped in ARC GIS every 10 minutes, and a spatial regression model converts the data into green-to-red colors, indicating good-to-poor air quality.

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| Location<br>(City, Counties, Region) | City of Keene, New Hampshire |
| Population/Number of homes covered by project | • Population: 22,786 (2019)<br>• Households: 9,192 (2019) |
| Objectives<br>(NAAQS attainment/maintenance, indoor air, visibility, air toxics, public education) | • Monitor and reduce fine particles ($PM_{2.5}$) from wintertime woodsmoke.<br>• Remain in attainment with the daily $PM_{2.5}$ National Air Quality Standard (NAAQS).<br>• Better understand current air inversions in Keene to predict future air inversions.<br>• Use social media and text alerts to encourage the public to follow EPA Burn Wise principles (burning the right wood, the right way, in the right appliance) and to voluntarily reduce burning activities during predicted times of elevated $PM_{2.5}$. |
| Milestones<br>(Project time frame, number of changeouts, air quality goals, number of low-income homes targeted if applicable) | • November 2014: Keene State College (KSC) students used Purple Air sensors to collect air-monitoring data.<br>• November 2017: KSC students start field-validation studies of Purple Air sensors.<br>• December 2017-Present: KSC students collect $PM_{2.5}$ data using Purple Air sensors.<br>• Created www.keenecleanair.org website with real-time corrected sensor data and spatial regression.<br>• Created and maintained Keene Clean Air Facebook page with 300 to 1500 people reached per post. |
| Budget<br>(projected/actual cost) | • $75,000 |

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| Funding Sources (government funds, grants, Supplemental Environmental Project, fees, etc.) | • $25,000 from EPA Region 1 2015 Healthy Communities Grant Program.<br>• $25,000 from EPA Region 1 2018 Healthy Communities Grant Program.<br>• $25,000 from EPA Region 1 2020 Healthy Communities Grant Program.<br>• Research supported by New Hampshire IDeA Network of Biomedical Research Excellence. NH-INBRE is funded through an Institutional Development Award (IDeA), P20GM103506, from the National Institute of General Medical Sciences of the NIH. |
| Partners (government/private organizations involved) | • Nora Traviss, PhD, Keene State College<br>• EPA Region 1<br>• NH Department of Environmental Services (NHDES)<br>• Southwest Region Planning Commission (Keene, NH)<br>• City of Keene, NH<br>• Keene High School<br>• Cheshire Medical Center (Keene, NH) |
| Incentives Offered (rebates, discounts, vouchers, incentives for low-income homes, etc.) | • This is a voluntary citizen-science program developed by a Keene State College professor to collect data on local PM levels and to alert residents to potentially harmful PM events due to wood burning. |
| Ordinances/Regulations (mandates for cleaner-burning hearth devices) | • No state mandates for replacing old stoves. |
| Project Yardstick (number of woodsheds constructed, number of stoves replaced with new stoves or other technology, etc.) | • 5 public-education workshops were held to encourage citizens to subscribe to EnviroFlash and consider using air sensors: led to 77 Keene subscribers, 197 Keene Clear Air Facebook followers, and 15 citizens interested in air-sensor installations.<br>• 4 Purple Air units installed 2018-2019 winter.<br>• 8 Purple Air units installed 2019-2020 winter.<br>• Website developed displaying real-time (10-minute average) Purple Air $PM_{2.5}$ concentrations on a map of Keene. Real-time data is also uploaded to the Purple Air website. |
| Outreach/Marketing (radio/TV public service announcements, workshops, woodstoves expo, flyers, mailouts, social media) | • Yearly outreach and education campaigns targeted at residents in Keene area.<br>• Yearly outreach to local high school and public service announcement video competitions.<br>• Website showing real-time air quality: https://www.keenecleanair.org/Homepage.html<br>• Facebook platform to encourage public to voluntarily participate in no-burn evenings. |

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| Air Quality Data/Other Results (current project area's air quality status and is improving indoor air quality part of project) | • Keene's valley location makes it susceptible to poor air quality from temperature inversions during winter. Keene is in attainment with the annual and daily $PM_{2.5}$ NAAQS. However, during winter, local air inversions can cause short-term spikes in $PM_{2.5}$ concentrations. Keene experiences inversions of variable strengths and duration. This project led to better understanding of air inversions: 1) The degree of cloud cover is an important variable in predicting inversions. 2) Temperature inversions typically occur at altitudes less than 300 feet. 3) The probability of an air inversion is highest when five or more air sensors measure $PM_{2.5}$ levels above 30 $\mu g/m^3$.<br>• Neighborhoods with high $PM_{2.5}$ tend to have high housing density.<br>• KSC's website displays real-time air-quality data during winter. An average of 5 alerts were issued per heating season based on the real-time air-quality data. |
| Lessons Learned (What worked? What didn't? Tips? How can project be improved?) | • Notifications via Facebook proved unreliable and did not notify residents quickly enough for Keene residents to act during predicted air inversions. A public text-alert system should be developed instead.<br>• Public trust is key; predictions need to be accurate.<br>• Education and outreach must be conducted frequently.<br>• Regional weather predictions often miss air inversions in Keene so a predictive model for local air inversions is needed.<br>• Drone technology is useful in confirming inversions.<br>• Installation of air monitors is complicated by need for proximity to participant's WiFi router, access to outdoor AC power, and placement away from confounding sources of $PM_{2.5}$. This led to only about half of interested citizens getting a sensor installed.<br>• Safety recall on power cords from Purple Air in December 2018 led to removal of six units for the 2018-19 winter season. New power cords were received in spring 2019 and 8 units were installed for 2019-20 winter.<br>• Intermittent Wi-Fi connectivity issues and frequent software downloads led to data gaps, typically less than 48 hours. However, the most common technical issue was the need to reboot sensor.<br>• Fluctuation in citizen interest can lead to data gaps. A drop in citizen participation occurred due to the pandemic. |
| Project Contact (name, organization, phone number, email address, web link to project) and EPA Regional Office Contact | • Nora Traviss, Keene State College (ntraviss@keene.edu)<br>• https://www.keenecleanair.org/Homepage.html<br>• See also https://www.keenecleanair.org/Infographic.html<br>• Alison Simcox, EPA Region 1 (mailto:Simcox.alison@epa.gov) |